

CLAIMS

1. A method to prevent or reduce agglomeration of magnetic particles wherein the magnetic particles are exposed to a varying magnetic field.

2. A method to determine the spatial distribution of magnetic particles in an examination area of an object of examination with the following steps:
 - a) Generation of an imaging magnetic field with a spatial distribution of the magnetic field strength such that the area of examination consists of a first sub-area with lower magnetic field strength and a second sub-area with a higher magnetic field strength,
 - b) Change of the spatial location of both sub-areas in the area of examination so that the magnetization of the particles changes locally,
 - c) Acquisition of signals that depend on the magnetization in the area of examination influenced by this change, and
 - d) Evaluation of said signals to obtain information about the spatial distribution of the signals in the area of examination, wherein the magnetic particles before or during the determining of the spatial distribution of the magnetic particles in the examination area are exposed to a varying magnetic field at least some of the time, more particularly periodically or continuously such as to reduce or prevent agglomeration of the magnetic particles.

3. A method according to claim two, characterized in that the gradient field in the area of examination has a varying magnetic field superimposed on the imaging magnetic field at least some of the time, more particularly periodically or continuously, more particularly, in at least parts of the first sub-area with lower magnetic field strengths.

4. A method as claimed in claim 1, characterized in that the strength of the varying magnetic field is sufficient to cancel out those attractive forces resulting in the clumping or agglomeration between neighboring particles in the area of examination

5. A method as claimed in claim 1 or 2, characterized in that the varying magnetic field is applied, more particularly, at an equal strength in all three spatial components.
- 5 6. A method as claimed in any one of the preceding claims, characterized in that the particles have an average size or expansion of at least 30, more particularly, at least 40 nm.
- 10 7. A method as claimed in any one of the preceding claims characterized in that the varying magnetic field can be applied, locally restricted, in the area of examination until the clumping or agglomeration of magnetic particles in this location is at least partially resolved.
- 15 8. A method as claimed in any one of the preceding claims, characterized in that a varying magnetic field with a frequency in the range of approx. 1 kHz to 10 MHz, preferably 10 to 500 kHz is used.
- 19 9. A method as claimed in any one of the preceding claims, characterised in that the field strength of the varying magnetic field is at least two times higher than the field strength of the imaging magnetic field.
- 25 10. A method as claimed in any one of the preceding claims, wherein the magnetic particles are monodomain particles and wherein the field strength of the varying magnetic field is at least 30, preferably at least 50 mTesla.
11. A method as claimed in any one of claims 1 to 9, wherein the magnetic particles comprise a nonmagnetic core covered with a magnetic coating and wherein the field strength of the varying magnetic field is at least five mTesla.

12. A method as claimed in any one of the preceding claims, wherein the varying magnetic field has a power of at least 500 W and is applied in intermittent pulses such that the average power input is less than 500 W.

5 13. A method according to any one of the preceding claims, wherein the varying magnetic field is applied as one or more pulses having an amplitude reducing to zero in a time sufficient to increase the distance between agglomerated particles sufficiently to prevent re-agglomeration.

10 14. A method according to any one of the preceding claims, wherein the magnetic particles are in a liquid medium in the examination area and the frequency of the varying magnetic field is chosen in view of the viscosity of said medium.

15 15. A method according to claim 14, wherein the medium surrounding the magnetic particles is blood and the frequency of the varying magnetic field is between 0.7 and 1.3 MHz.

20 16. A method according to any one of claims 2 to 15, wherein the varying magnetic field is applied to magnetic particles shortly before administering to the examination area.

25 17. A method according to any one of claim 2 to 15, wherein magnetic particles are administered to the examination area in an agglomerated state and wherein in only a part of the examination area the particles are de-agglomerated.

18. A method according to any one of claims 2 to 17, wherein the frequency of the varying magnetic field is close to the frequency of the imaging magnetic field and wherein the exposure to the varying magnetic field and the exposure to the imaging magnetic field alternates.

19. A method according to claim 18, wherein the frequency of the varying magnetic field is 0.8 to 1.2 times the frequency of the imaging magnetic field.

20. A method as claimed in any one of the preceding claims, characterized
5 in that the magnetic particle is a multi or mono-domain particle that can be reverse magnetized by Neel rotation and/or that the reverse magnetization is caused by Brownian rotation.

21. A method as claimed in any one of the preceding claims, characterized
10 in that the magnetic particle is a hard or soft magnetic multi-domain particle.

22. An apparatus to determine the spatial distribution of magnetic particles in an area of examination in an object of examination comprising:

- a) means to generate a magnetic field with a spatial distribution of the magnetic field strength such that the area of examination consists of a first sub-area with lower magnetic field strength and a second sub-area with a higher magnetic field strength,
- b) means to change the spatial location of both sub-areas in the area of examination so that the magnetization of the particles changes locally,
- c) means for the acquisition of signals that depend on the magnetization in the area of examination influenced by this change,
- d) means for the evaluation of said signals to obtain information about the spatial distribution of the signals in the area of examination and
- e) means to impose in the area of examination, more particularly, in at least parts of the first sub-area with lower magnetic field strengths, a varying magnetic field at least some of the time, more particularly periodically or continuously.

23. Magnetic particle composition having a magnetization curve having a step change, the step change being characterized in that the magnetization change, as
30 measured in an aqueous suspension, in a first field strength window of magnitude delta

around the inflection point of said step change is at least a factor 3 higher than the magnetization change in the field strength windows of magnitude delta below or in the field strength windows of magnitude delta above the first field strength window, wherein delta is less than 2000 microtesla and wherein the time in which the

- 5 magnetisation step change is completed in the first delta window is less than 0.01 seconds.

24. Use of the magnetic particle composition according to claim 23 in a method according to anyone of claims 1 to 21.